DEEPEGS

DEPLOYMENT OF DEEP ENHANCED GEOTHERMAL SYSTEMS FOR SUSTAINABLE ENERGY BUSINESS

Composition of reservoir fluids in well IDDP-2

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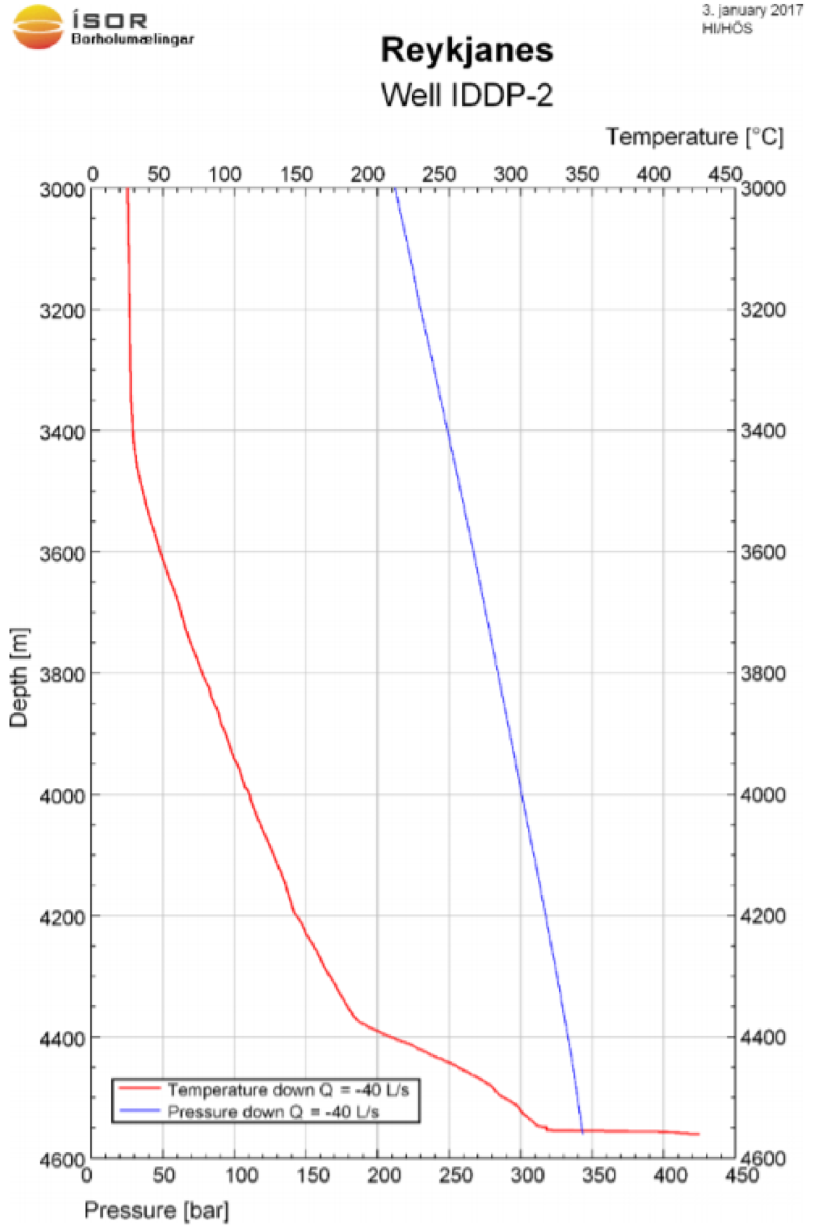
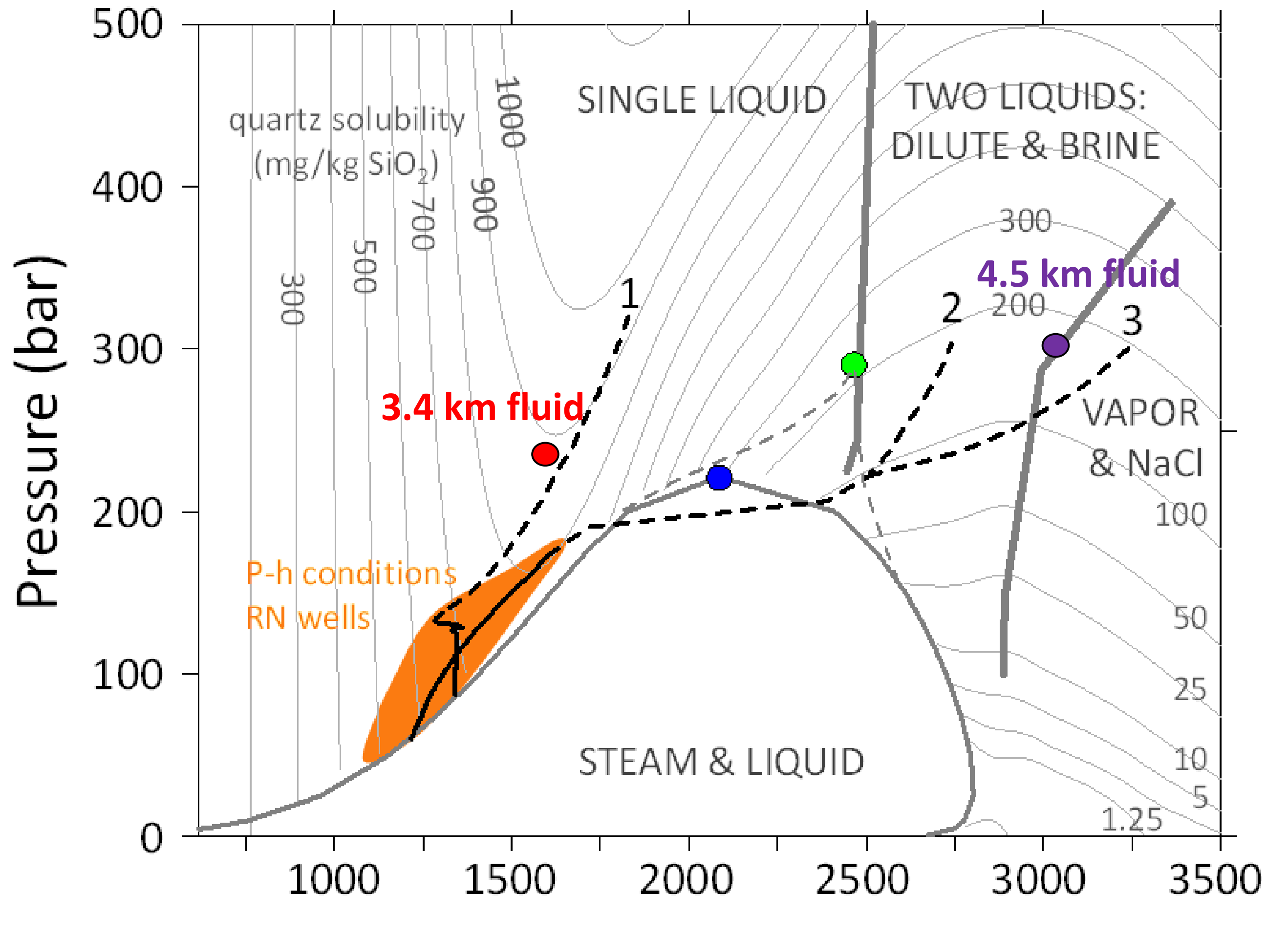
Well IDDP-2

- Three major feed zones
  - 2.3 km
    - Feed zone of RN-15, 275°C
  - 3.4 km
    - 350°C, 230 bar
  - 4.5 km
    - 530°C, 280-310 bar
- Predicted that 90-95% of discharge will come from the 3.4 km feed zone and 5-10% from 4.5 km depth



What to do and how to do it?

- Characterise the fluids at each feed zone depth
- Calculate mixing of the fluids at 3.4 km (350°C)
- Simulate boiling of the mixed fluids to 70 bar-a
- Assess pH, gas content, salinity and deposition of solids



Friðriksson et al., WGC, 2015

Modelling of fluid composition

- 3.4 km feed zone
  - Composition estimated from conventional Reykjanes fluid
    - SOLVEQ-XPT and CHIM-XPT (Reed et al., 2010)
  - Reconstructed fluid from RN-12 at 295°C was used as basis
    - Equilibrated with PbS, ZnS, $CuFeS_2$ and tholeiite
    - In equilibrium with anhydrite, chlorite, epidote, quartz etc.
  - Heated from 295°C to 350°C in steps of 1°C
    - 400 mg of sulphides and 100 mg of basalt dissolved in 1 kg
  - Final fluid at 350°C has pH = 5.53 and 75 ppm H_2S
    - In equilibrium with anhydrite, epidote, garnet, actinolite, quartz, clinozoisite and sulphides

Modelling of fluid composition

- 4.5 km feed zone
  - Composition estimated from analogy with supercritical seawater – dilute phase and brine
  - Samples from "F" vent at EPR (von Damm et al., 1997)
    - Dilute fluid: T = 388°C, pH = 2.8, H_2S = 1400 ppm, Cl = 1650 ppm
    - Brine: T = 351°C, pH = 2.6, H_2S = 300 ppm, Cl = 30000 ppm
  - Fluids were heated stepwise from 25°C to 350°C assuming no dissolution or precipitation
    - Dilute fluid: pH = 4.14, saturated with anhydrite and pyrite
    - Brine: pH = 4.13, saturated with anhydrite, pyrite and quartz

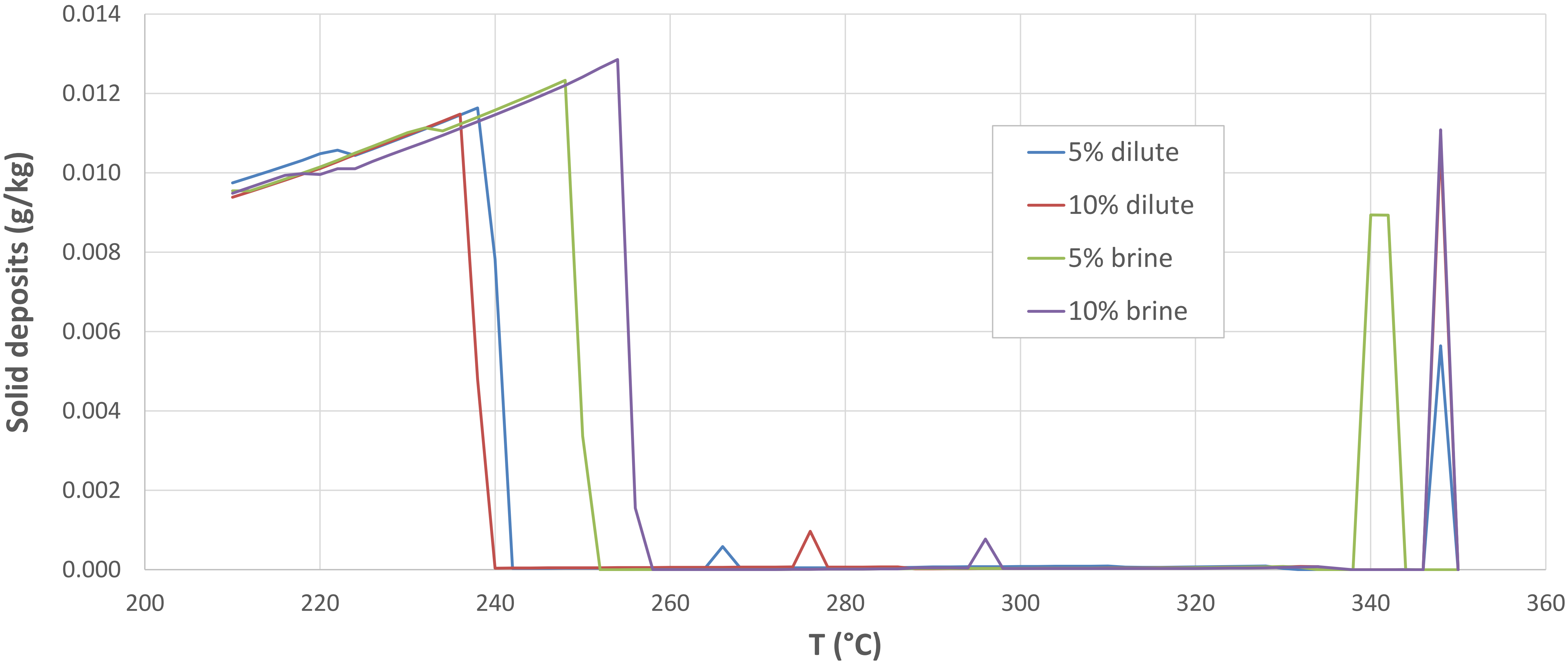
Fluid mixing

- Four mixtures were calculated at 350°C
  - Assume single liquid phase after mixing
- The fluid composition is dominated by RN fluid
  - pH, Cl, SiO_2, CO_2 manageable
  - H_2S concentration very high, specially for dilute fluid mix
  - Fe and Mn high for brine mix
- Supersaturated with sulphides and iron oxides
  - Slightly supersaturated with anhydrite

Production of mixed fluid

- Mixed fluids boiled from 350°C to 286°C (70 bar-a)
  - Leading to vapour fraction of about 25%
- The total amount of deposits is 10-20 mg per kg
  - Mainly anhydrite, haematite, bornite and phyllosilicates
- The vapour has 6000 ppm CO_2 and 300-700 ppm H_2S
  - No data for other gases
- The liquid has pH 3.8-4.5, 800-900 ppm SiO_2, 10-30 ppm H_2S, 8-80 ppm Fe and 1-20 ppm Cu, Mn, Pb, Zn
  - Still high potential for sulphide deposition
  - Major deposition at 20-40 bar in conventional RN fluids

Solid deposition during boiling



Conclusions

- The fluid produced from IDDP-2 will be a mixture from 3.4 and 4.5 km
  - Hotter Reykjanes fluids at 3.4 km depth
  - T/P and drill cores suggest supercritical two-phase seawater at 4.5 km depth
- Modelling suggests that the fluid will be manageable at 70 bar-a in terms of pH, salinity, gas content and scaling potential
  - Further boiling is likely to result in substantial scaling (100-300 mg/kg)
    - Sulphides from about 40-45 bar-a, then amorphous silica